FOREST GENETICS CENTER
R. T. BINGHAM

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United States Department of Agriculture
Bureau of Entomology and Plant Quarantine

STATUS OF WHITE PINE BLISTER RUST CONTROL ON JANUARY 1, 1939

Prepared by the Division of Plant Disease Control

INTRODUCTION

This circular has been prepared to answer numerous questions about the progress of blister rust control to date in various sections of the United States, the extent of the pine areas still without initial protection, and the effectiveness of control measures.

Blister rust is a fatal disease to five-leaf pines, of which the most important commercial forests are those of northern white pine extending from Maine to Minnesota and south to Georgia, western white pine of the northern Rocky Mountain area centering in Idaho, and sugar pine of California and Oregon.

It is controlled by the destruction of currant and gooseberry plants (Ribes) among and near the trees, since blister rust cannot spread from pine to pine, but only from pine to Ribes plants and from them back to pine. The first coverage of pine forests for the destruction of the Ribes must usually be followed, in the case of a large proportion of the stands, by one or more subsequent workings to get missed bushes, sprouts, and seedlings.

GENERAL SUMMARY OF PROGRESS OF INITIAL PROTECTION, 1916-1938

The blister rust control areas in the United States, that is, areas supporting valuable present and future commercial stands of white pine plus the protective borders around these stands, aggregate over 29,000,000 acres. The status of control work on January 1, 1939, is summarized in table 1.

Table 1.--Status of Control as of January 1, 1939.

I.	The estimated acreage of the blister rust control area in the United States that should be protected by the eradication of Ribes.....	29,042,738
	(About half of this consists of pine stands and the other half is the surrounding border zone.)	

II. The net acreage of the control area initially protected totals..... 19,924,009

Northern white pine (Eastern States).....	17,481,695
Western white pine (northeastern Washington, northern Idaho, and northwestern Montana).....	1,790,604
Sugar pine (California and Oregon).....	651,710

III. The estimated acreage of that part of the control area still unprotected totals..... 9,118,729

Northern white pine.....	6,134,212
Western white pine.....	908,801
Sugar pine.....	2,075,716

IV. The cost of blister rust control activities (including research prior to 1934) from 1916 to June 30, 1939, totals..... $29,960,243

1. Bureau of Entomology and Plant Quarantine (and Bureau of Plant Industry prior to 1934)..... $19,200,207
   - (a) Emergency Relief funds, 1934–June 30, 1939..... $12,641,728
   - (b) Regular appropriations, 1916–June 30, 1939..... $6,558,479

2. Cooperating agencies..... $10,760,036
   - (a) State and private, including cash and contributed services, 1916–June 30, 1939..... $4,922,456
   - (b) Forest Service, including regular and emergency funds for work on national forest lands, 1931–June 30, 1939..... $5,805,083
   - (c) National Park Service, regular funds 1930–1933..... $32,497
   - (d) CCC labor has been used wherever practicable on lands in all classes of ownership.

V. The average cost per acre:

Location	Using regular funds	Using emergency funds
Eastern States	50¢ to $1.00	$1.00 to $2.00
Western States	$3.00 to $5.00	$6.00 to $9.00

Costs vary with topography, density of ground cover, number and size of Ribes, etc. They are higher in the West because the pine areas are in remote mountainous areas, requiring the use of camps, and Ribes and working conditions are more difficult. The increased cost of work performed with emergency funds is due to the less experienced labor, a short work month, divers county wage rates, the additional fiscal and statistical reports required by the relief agencies, and the limitations on expenditure of relief funds for supervision.

PROGRESS OF CONTROL ON FEDERAL PROPERTY

The control work is coordinated and technically supervised by the Bureau of Entomology and Plant Quarantine, and the above figures include the work performed by all cooperating agencies (with the exception of 36,619 acres of experimental work in the limber pine and whitebark pine forests of Colorado and Wyoming, which are not at present considered as part of the commercial white pine areas). An important part of the forest area producing white pines is owned by the Federal Government. It is located in the National Forests which come under the administration of the Forest Service of the Department of Agriculture, and in the Public Domain, National Parks, and Indian Reservations which come under the administration of the Department of the Interior. The costs of labor for these forest areas have largely been financed by the organizations administering these lands and by emergency relief allotments. A brief description of the results accomplished in cooperation with these agencies is given below.

National Forests

Less than a third of the white pine acreage in the national forests is in the Eastern States. The initial work has been completed on the White Mountain National Forest and is well along in the national forests in the Appalachian and Lake States regions.

The major part of the national forest white pine land is in the western white pine and sugar pine regions where it constitutes about half of the control area needing protection. The control work has been done with CCC and WPA labor, and labor employed on regular funds. In the western white pine region about three-fourths of the national forest white pine lands have received initial protection, and nearly one-third of these lands in the sugar pine region.

National Parks

Initial control work has been practically completed in Acadia National Park in Maine, Shenandoah National Park in Virginia, and Mt. Rainier National Park in Washington. There is still a small amount of work to be done in Crater Lake Park in Oregon and Great Smoky National Park in North Carolina. During the past season some initial work in Ribes eradication was performed in California on Lassen-Volcanic, Yosemite, and General Grant National Parks, and pre-eradication surveys were made on the Sequoia National Park to determine the amount of needed control work. Control work in national parks has been performed almost entirely with CCC labor.

During the past season a survey was made in Yellowstone National Park to determine the portions that should be protected from blister rust. As a result, 6 areas totalling 12,900 acres were selected for control work. In selecting areas for protection, consideration was given to scenic and recreational areas supporting white pine growth and to specimen stands.

The disease was found this year for the first time in Glacier National Park, where it occurred on Ribes at several places. In this park some work will be needed on selected areas.

Control work aggregating over 200,000 acres still remains to be done on the national parks in the Western States.

Indian Reservations

The Indian reservations that contain valuable white pines are located in Wisconsin and Minnesota. Control work has been carried on with labor furnished by the Indian Service under the technical direction and supervision of the Bureau of Entomology and Plant Quarantine. Work has been carried on in the Red Lake, Net Lake, Vermilion, Leech Lake, Menominee, Grand Portage, Lac Court Oreilles, and Bad River Reservations. Over four-fifths of the initial work has been completed on these reservations.

Public Domain

About 38,408 acres of public-domain lands bearing white pine intermingled with national forest, State, and private lands are in the western white pine region. These lands are being protected along with the lands in other ownerships with which they are intermingled. Nearly half of these lands have received initial protection.

In addition about 113,786 acres of white pine and sugar pine forest are in the "O and C revested lands" in Oregon, most of which is in need of initial protection.

PROGRESS OF CONTROL WORK BY REGIONS

The rate of progress has varied in the different white pine regions. Control work on a large scale was begun in the northeastern section of the northern white pine region in 1922, and extended to other parts of the region in 1932 and 1933; it was started in the western white pine region in 1931 and in the sugar pine region in 1933. During the period 1922-33 most attention was given to control operations in New England and New York, where the disease was most prevalent and causing serious damage. In the other portions of the country, where the disease was either absent or was progressing much more slowly, control work remained in the developmental stage until the spread of the rust made large-scale Ribes eradication necessary.

The rust was discovered in the Idaho western white pine region in 1927 and on sugar pine in California in 1936. Practical control measures have been developed and applied on a large scale in both the western white and sugar pine regions to protect as much of the pine as possible ahead of the destructive spread of the disease.

Beginning in 1933, control work in all white pine regions was greatly stimulated and expanded by the allotment of emergency funds for relief of unemployment. These funds came at an opportune time because the disease had reached the damaging stage in all regions except the sugar pine area, and the need for increasing the scope of control activities was very pressing. Blister rust control afforded opportunity for the employment of a large amount of labor, and most of the funds went into wages. These allotments provided the control work in all regions with its first large supply of man power. In addition, labor from CCC camps has been used wherever available within working distance of white pine stands needing protection. As a result more white pine acreage has been cleared of Ribes since 1933 than was accomplished in all previous years combined.

The status of control work at the end of 1938 is shown in table 2.

Table 2.--Status of White Pine Blister Rust Control by Regions on January 1, 1939.

Species and regions	Control area[1] including border zones (Acres)	Initially protected control area[1] (Acres)	Areas reworked subsequent to initial protection (Acres)	Effective labor (Man-days)	Ribes destroyed (Number)	Estimated remaining area needing initial protection (Acres)
Northern white pine:						
Northeastern	13,652,432	10,141,962	3,383,592	2,322,469	248,501,955	3,510,470
Southern Appalachian	5,280,173	4,855,221	767,044	195,448	22,591,102	424,952
North Central	4,683,302	2,484,512	197,694	713,965	186,806,819	2,198,790
Western white pine:						
Northwestern Washington, northern Idaho, and northwestern Montana	2,699,405	1,790,604	206,843	1,562,746	367,050,892	908,801
Sugar pine:						
California and Oregon	2,727,426	651,710	119,239	415,677	104,063,802	2,075,716
Total	29,042,738	19,924,009	4,674,412	5,210,305	929,014,570	9,118,729
Limber, whitebark, and bristlecone pines:						
Colorado and Wyoming[2]	----	36,619	1,962	13,896	1,583,306	----
Grand total	29,042,738	19,960,628	4,676,374	5,224,201	930,597,876	9,118,729

[1] The control area and initially protected acreages shown are net totals to January 1, 1939, and do not include areas worked and later removed from control-area status owing to cutting the pine or for other reasons. However, the other figures in the table are gross totals.

[2] The work in Colorado and Wyoming represents experimental Ribes eradication in stands of limber, whitebark and bristlecone pine on National Forests to develop practical control measures for the Rocky Mountain region in advance of the spread of the rust. The acreages shown for these two States are not at present considered as part of the commercial white pine areas of the United States.

Northeastern Region

Control work in the Northeastern region comprising New England, New York, Pennsylvania, and New Jersey has been under way much longer than in the other white pine regions. Of the 13,652,432 acres of white pine land 1/ needing protection from blister rust, 10,141,962 have been initially cleared of Ribes, and 3,383,592 reworked. This work has resulted in the destruction of 248,501,955 Ribes with 2,322,469 man-days of labor. The disease has been effectively checked and brought under control on the treated areas. The initial eradication of Ribes is largely completed in the native white pine stands within the control area in New Hampshire, Massachusetts, Rhode Island, and New Jersey. In the other States comprising this group the completion of the initial work ranges from one-third to four-fifths of the control areas in the various States. In Pennsylvania Ribes eradication began at a much later date than in the other Northeastern States. Approximately 3,510,470 acres are still unprotected in the region. In addition, a large acreage needs reworking to maintain control of the rust. The cooperating States and local agencies have provided $3,339,460 for this work in cash and contributed services.

Most of the white pine land in this region is in State and private ownership. A small amount occurs on the White Mountains and Allegheny National Forests and in Acadia National Park. The initial control work has been completed on the White Mountain National Forest, and most of the necessary work on the Allegheny National Forest has been finished. Also, initial control work has been completed in Acadia National Park and some of the area reworked. These areas are now considered on a maintenance basis.

Southern Appalachian Region

Control work in the Southern Appalachian region comprising the States of Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Kentucky and Georgia was first started on a large scale in 1933 when emergency relief funds became available. Of the 5,280,173 acres of white pine land 1/ estimated as needing protection from blister rust, 4,855,221 have been initially cleared of Ribes and 767,044 reworked. This work has resulted in the destruction of 22,591,102 Ribes with 195,448 man-days of labor. Initial Ribes eradication has been completed in the white pine forest areas of Kentucky and South Carolina and is well along in the other States in this region. Approximately 424,952 acres are known to be unprotected. This acreage may be increased when pine surveys now under way have been completed. In addition, a considerable acreage will have to be reworked to maintain control of the rust. The cooperating States and local agencies have provided $70,676 in cash and contributed services for this work.

The disease has spread southward in this region as far as central Virginia and West Virginia, and on treated areas within the infected region the rust has been brought under control. South of the known limits of infection large areas have been cleared of Ribes to protect the pines before

1/ Control area.

they become infected and to retard the advance of the disease. The initial eradication of Ribes has gone forward rapidly, as these plants are usually localized in distribution and less numerous than in other white pine regions.

White pine is increasing in the Southern Appalachian region and often replaces chestnut that has been killed by the chestnut blight. While much of the white pine is in the reproductive or pole stage, its increase in forest areas is considered highly desirable. Most of the white pine land in this region is in State and private ownership. However, a small amount of white pine occurs in the national parks and a considerable acreage in the national forests. A large proportion of the known white pine areas in the national forests and parks have received initial protection from the disease.

North Central Region

Control work in the North Central region comprising Michigan, Wisconsin, Minnesota, Ohio, Indiana, Illinois, and Iowa was begun on a large scale in 1932. Of the 4,683,302 acres of white pine land 2/ needing protection from blister rust, 2,484,512 acres have been initially cleared of Ribes and 197,694 acres reworked. This work has resulted in the destruction of 186,-806,819 Ribes with 713,965 man-days of labor. Studies show that the disease has been effectively checked and brought under control on the treated areas. Ribes are abundant, working conditions difficult, and control work is not so far advanced as in the Northeastern and Southern Appalachian regions. Approximately 2,198,790 acres are still unprotected. In addition, a considerable acreage needs reworking to maintain control of the rust. The cooperating States and local agencies have provided $409,227 for this work in cash and contributed services.

This region has a large acreage of national forest land and over two-thirds of the native and planted white pine stands on these lands have been initially protected with CCC labor.

There are also several Indian reservations in Wisconsin and Minnesota containing valuable stands of white pine. Control work has been carried on with labor furnished by the Indian Service on the Red Lake, Net Lake, Vermilion, Leech Lake, Menominee, Grand Portage, and Bad River Reservations. Over four-fifths of the initial work has been completed on these reservations.

Western White Pine Region

In the western white pine region of eastern Washington, northern Idaho, and western Montana a total of 2,699,405 acres comprising the best white pine sites have been included in blister rust control areas for the continuous production of western white pine. Of this acreage 1,790,604 have been initially cleared of Ribes and 206,843 reworked. This work has resulted in the destruction of 367,050,892 Ribes with 1,562,746 man-days of labor. Approximately 908,801 acres are unprotected. In addition, large acreages need reworking to maintain control of the rust. The above figures include a small amount of work in Mt. Rainier National Park. The cooperating States and local agencies have provided $608,893 for this work in cash and contributed services.

2/ Control area.

The rust is spreading rapidly in the western white pine forests, and some areas of young growth are now so heavily diseased as to be a total loss. Damage on the unprotected areas will continue to increase until the Ribes are removed. On the treated areas the disease has been effectively checked and brought under control. The remaining control area is in pressing need of initial eradication.

About half of the western white pine control acreage is in Federal ownership on the national forests. The Forest Service has largely provided the labor for Ribes eradication on these national forest lands. In addition, the Bureau of Entomology and Plant Quarantine has initially eradicated the Ribes on 36,619 acres of limber and whitebark pine forests on national forest lands in Colorado and Wyoming. This was large-scale experimental work to develop practical control methods for these forests.

The National Park Service has used CCC labor to destroy the Ribes on about 13,000 acres of selected white pine areas in Mt. Rainier National Park. The initial control work in this park is practically completed, although some rework will be necessary to maintain control of the disease.

Sugar Pine Region

In the sugar pine region of Oregon and California 2,727,426 acres of the best sugar pine type have been included in the control areas. About half of this is national forest land in Federal ownership. A total of 651,710 acres have been initially cleared of Ribes and 119,239 reworked. This work has resulted in the destruction of 104,063,802 Ribes with 415,677 man-days of labor. There remain 2,075,716 acres needing initial protection from blister rust. The cooperating States and local agencies have provided $494,200 for this work in cash and contributed services. Control work on national forest lands has been carried on with labor provided by the Forest Service. Work has been performed on the Rogue River, Lassen, Plumas, Eldorado, Stanislaus, and Sierra National Forests.

Control work has been carried on in this region to protect as much of the white pine as possible in advance of the spread of the rust. The disease is present in Oregon and has spread southward a distance of 160 miles into the Sierra Nevada of California. Control work has been carried on as rapidly as available funds would permit, but most of the sugar pine type is still unprotected.

White pines are of great importance on several of the National Parks, including Crater Lake, Lassen-Volcanic, Yosemite, General Grant, and Sequoia. A small amount of work was carried on with CCC and WPA labor provided by the National Park Service in several of these parks during the past year, but there are still about 200,000 acres in need of initial protection from blister rust.

AREAS COVERED IN 1938

The figures previously given include the progress to December 31, 1938. That part of the acreage covered during the calendar year 1938 is shown in table 3.

Table 3.--Ribes Eradication during the Calendar Year 1938.

Region	Area covered (acres) Initial	Rework	Total	Effective labor (8-hour man-days)	Ribes destroyed
Northeastern	330,705	410,864	741,569	203,925	13,821,861
Southern Appalachian	663,442	71,566	735,008	40,828	4,750,971
Lake States	405,518	70,295	475,813	79,563	18,671,042
Western white pine1/	78,201	92,562	170,763	195,364	38,265,241
Sugar pine	69,379	40,174	109,553	119,258	23,093,653
Rocky Mountain	181	1,962	2,143	796	108,690
Total	1,547,426	687,423	2,234,849	639,734	98,711,458

1/ Includes work on Mt. Rainier National Park in addition to the work on national forests and State and private lands in the Inland Empire region.

REGIONS NOW INFECTED WITH BLISTER RUST

Introduction of Blister Rust

Blister rust reached the eastern part of the United States about 1898. A separate introduction from Europe in 1910 established the rust near Vancouver, British Columbia, where it was discovered in 1921. Following these introductions the rust has spread naturally until it is now present in every State along the Canadian border except North Dakota, and has been found southward as far as central Virginia, central West Virginia, central Ohio, northern Indiana, northern Illinois, central Iowa, southwestern Montana, central Idaho, and northern California, as shown on the accompanying map (fig. 1).

Spread of Rust during 1938

During the calendar year 1938 blister rust was found for the first time on either white pine or Ribes in 70 counties. Six of these counties are in the Southern Appalachian States, 60 in the North Central States, 2 in Montana, and 2 in California.

In the Southern Appalachian States the rust was found on white pine in Highland County, Va., and on Ribes in four counties in Virginia and one in West Virginia. These discoveries did not extend the spread of the disease farther south, but added new counties within the previously known limits of infection in the Southern Appalachian Region.

The most extensive spread of the disease into new territory occurred in the North Central States where weather conditions probably were more favorable for the dissemination of the rust. Infection was found for the first time on white pine in 8 counties in Ohio, Michigan, and Wisconsin, and on Ribes in 55 counties in the 7 States comprising the North Central blister rust control region. In 38 of the 55 counties infection occurred on the cultivated black currant, Ribes nigrum. The large number of counties in which the disease was found on cultivated black currants shows the importance of this species as a disseminator of the rust and the need for the eradication of Ribes nigrum in regions where the white pines are valuable forest and ornamental trees. The southern limits of the known infected area have been extended during the past year from one to three counties in Ohio, Indiana, Illinois, and Iowa. In addition, many newly infected counties were added within the previously known limits of spread.

In Montana the disease was found to be widely distributed on wild Ribes on both sides of the Continental Divide. Infection was found at 5 different points where inspections were made in Glacier National Park. This represents an eastward extension of the rust into Flathead and Glacier Counties. Glacier National Park is situated within these counties.

Rust infection on Ribes in California shows that the disease spread southward another 35 miles during 1938 and is now present about 160 miles below the Oregon-California border. Numerous other infections on Ribes were found within the sugar pine area previously reported as infected. No rust was found on sugar pine, as it takes from 3 to 4 years after infection for the resulting cankers to become easily discernible on pines, and sufficient time has not elapsed since discovery of the disease in the State to enable the field men to find it readily on sugar pine. However, it is very probable that scattered pine infections exist in northern California.

One of the most significant finds occurred in Shasta County about 80 miles south of the Oregon line. In 1937 scouting activities in this locality uncovered but two infected Ribes, each with but one leaf infected. A year later 300 infected Ribes, 50 of them Ribes nevadense, and the remainder R. roezli, were found to be heavily infected in the same vicinity.

Again, in Tehama County west of Mt. Lassen, scouting in 1937 showed no infection, while in 1938 over 100 infected R. roezli, R. inerme, and R. nevadense bushes were found in a small localized area. Such discoveries, both in good association with sugar pine, have laid the foundation for local infection on pines within the next few years.

GENERAL DISCUSSION OF THE CONTROL PROBLEM

White pine blister rust is a foreign tree disease that destroys the white or five-needled pines (fig. 2). Its introduction and spread in this country has created a serious disease-control problem involving the preservation of the white pines. These trees are of national importance because of their value, their wide distribution, their desirability as a component of forest stands, and their usefulness in providing economic stability for de-

pendent industries and communities. The purpose of blister rust control work is to conserve the white pines as forest trees on millions of acres of land where they are economically of great importance to forest development and productivity.

Life Cycle

The rust lives alternately on white pines and on wild and cultivated currant and gooseberry plants, commonly called Ribes. It is communicated between host plants by wind-borne spores (fig. 3). The disease spreads from pine to Ribes for distances up to 150 miles or more. From Ribes to pines the distance of spread varies from a few hundred feet to a mile or more under special conditions. Severe damage seldom occurs over 900 feet from Ribes. However, these plants are distributed so generally throughout forest areas that most of the white pines are within infecting range and therefore subject to destruction by this disease.

Damage

Blister rust kills the young pines rapidly, and seriously damages the larger trees, ultimately causing their death (figs. 4, 5, and 6). The loss of young growth, followed later by the death of older pines and seed trees, prevents natural regeneration and in time results in the commercial elimination of these species in forest stands. In numerous unprotected local areas within the infected region, losses ranging from partial to complete already have occurred. The younger growth in some areas is so badly diseased that it will be a total loss. Where the rust has been present a long time, older trees have been severely damaged and killed. However, if infected merchantable trees are discovered in time they usually can be salvaged before the rust has time to kill them. The loss of white pines in infected areas will continue until the disease is brought under control. In areas where the disease has been controlled by the eradication of Ribes, further losses have stopped.

Effectiveness of Control

Practical and effective control of blister rust in forested areas is obtained by removal of the Ribes (fig. 7). Numerous studies show that this work has stopped further infection of the pine, while in unprotected areas the disease continues to spread and destroy the trees. In order to protect pine stands to maturity, portions of the treated areas where Ribes were originally abundant must be worked once or twice at intervals of 3 to 5 or more years to remove any missed bushes, sprouts, or plants that have come up from seed in the soil. Control work has been highly successful in assuring the continued production of white pine in protected areas. These areas are considered on a "maintenance basis" after the initial eradication and after one or two reworkings of those portions that originally bore numerous Ribes. Areas on maintenance require very little work until there is some disturbance of the forest, such as that caused by fire or logging operations.

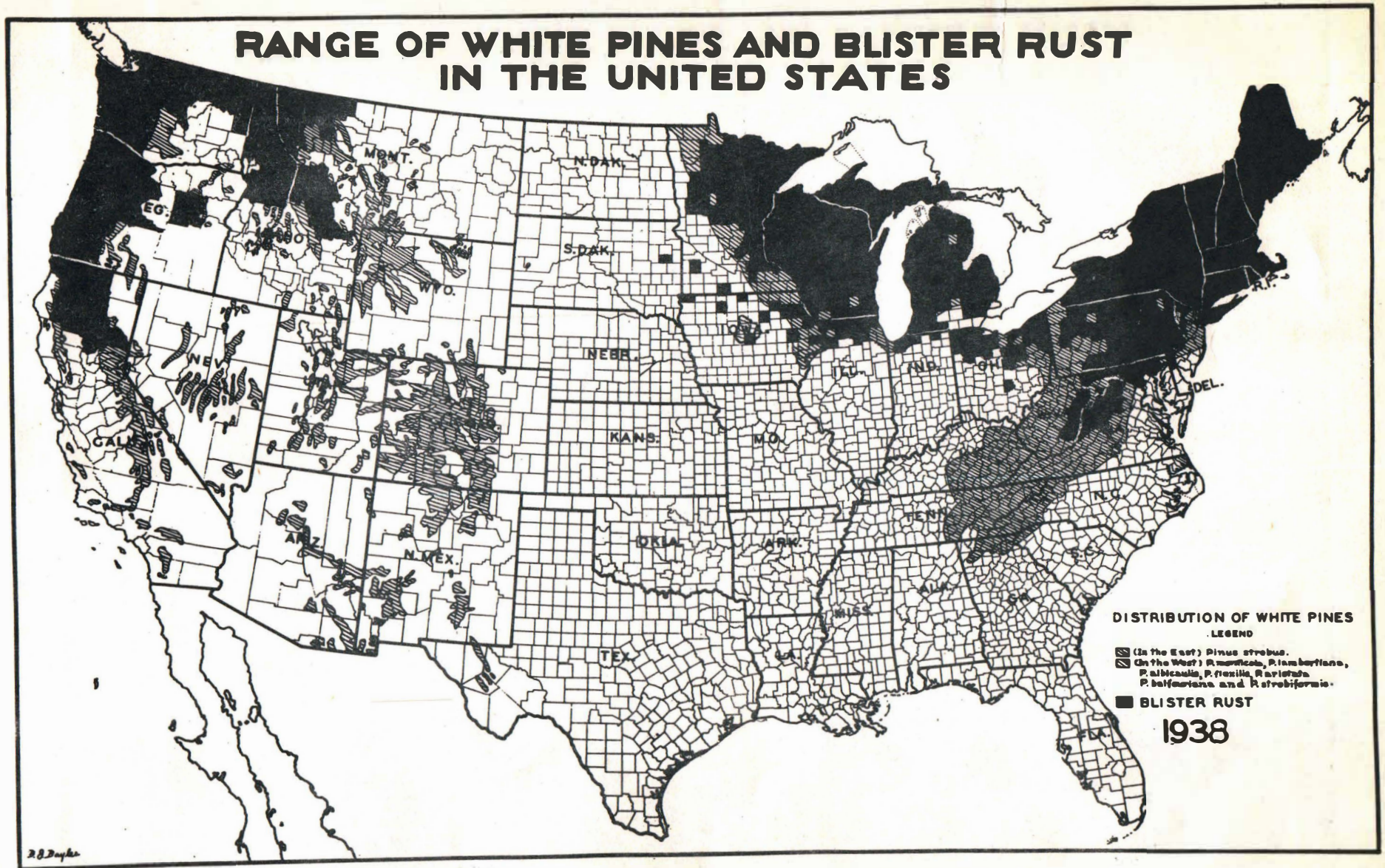
RANGE OF WHITE PINES AND BLISTER RUST
IN THE UNITED STATES
MONT.
N.DAK.
S.DAK.
WYO.
NEBR.
KANS.
NEV.
ARIZ.
N.MEX.
OKLA.
TEX.
ARK.
MO.
MISS.
TENN.
N.C.
S.C.
GA.
FLA.
ALA.
DEL.
DISTRIBUTION OF WHITE PINES
LEGEND
(In the East) Pinus strobus.
(In the West) P. monticola, P. lambertiana, P. albicaulis, P. flexilis, P. aristata P. balfouriana and P. strobiformis.
BLISTER RUST
1938
U.S. DEPARTMENT OF AGRICULTURE

Figure 1.

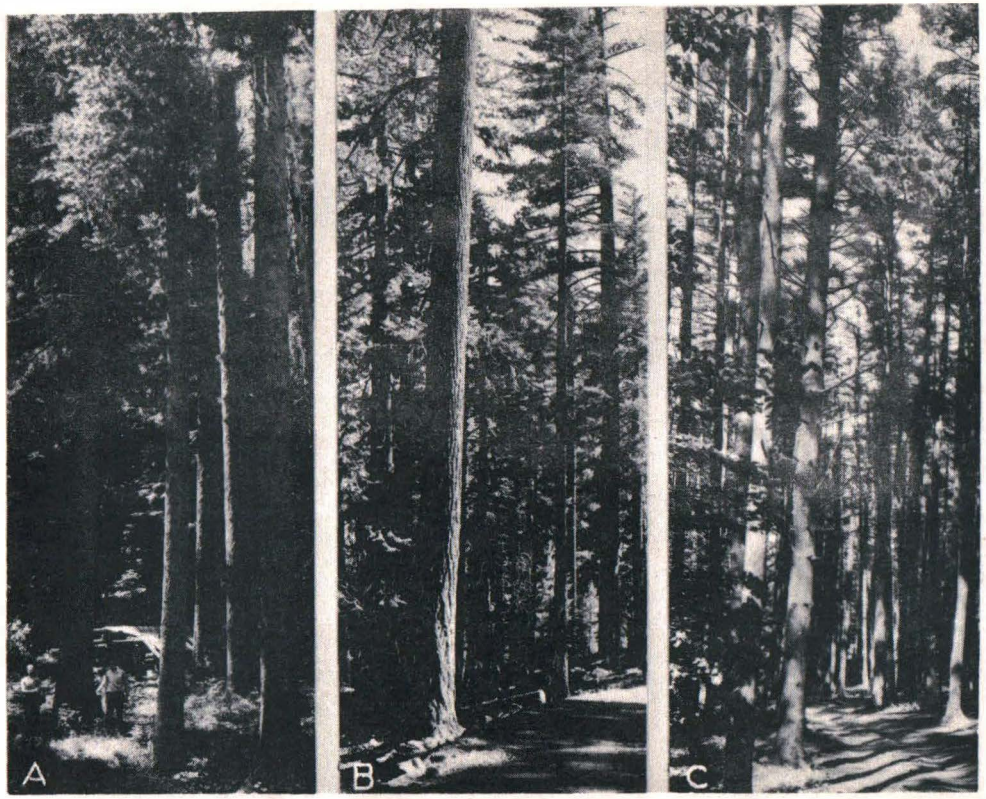

Figure 2.—Mature white pines. A, Western white pine; B, sugar pine; C, northern white pine.

Figure 3.—Blister rust fungus on white pines and Ribes. A, Diseased white pine showing blisters containing the spring spores that spread the rust from pine to Ribes; B, diseased Ribes leaf showing pustules containing the summer spores that spread the rust from Ribes to Ribes; C, diseased Ribes leaf showing outgrowths which produce the fall spores that spread the rust from Ribes to white pines.

Figure 4.—Blister rust damage to young white pines. A, Natural reproduction heavily infected with blister rust and showing dead trees in foreground; B, plantation of medium growth white pine heavily infected with blister rust. Each of the banded trees has been attacked by the disease.

Figure 5.—Blister rust damage. A, Large white pines dying from blister rust; B, top of white pine broken off at the point where it was girdled by blister rust canker.

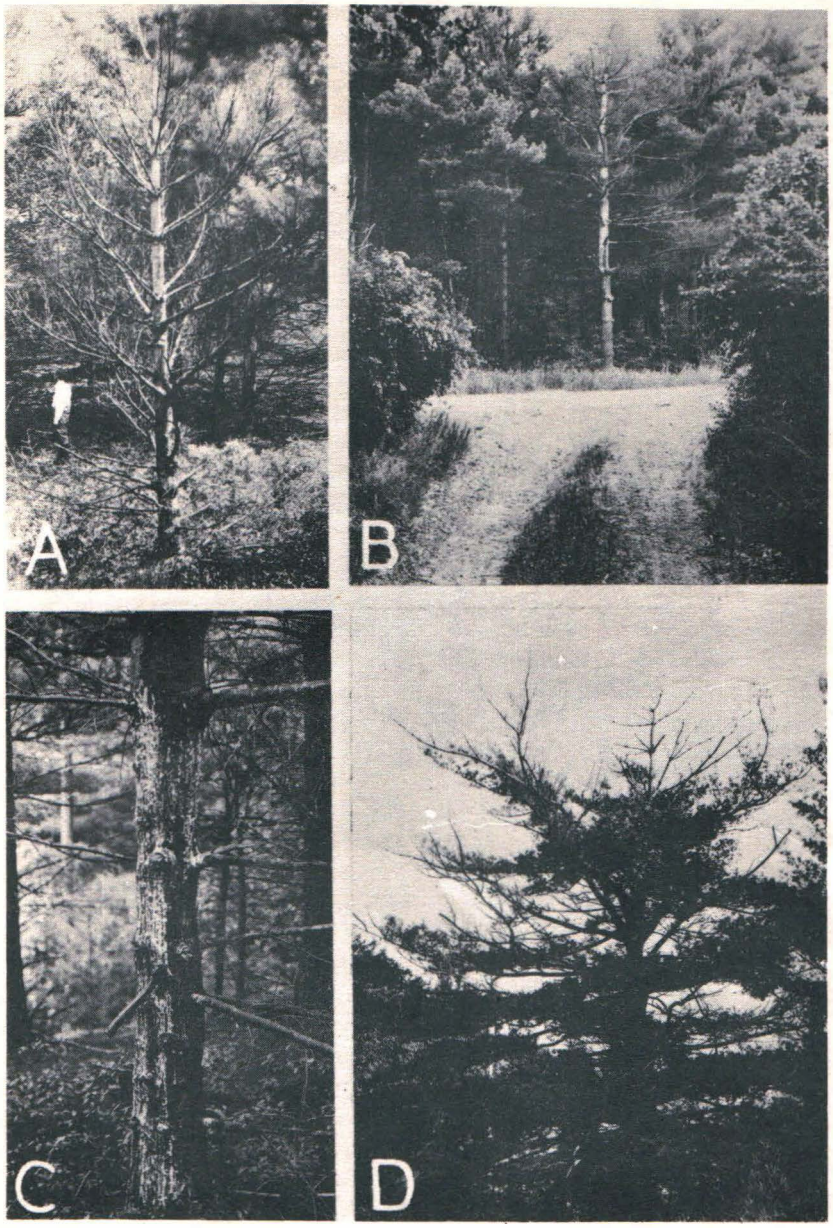

Figure 6.—Cultivated black currants damaged these white pines. A and B, Trees killed by rust; C, fatal blister rust canker on trunk; D, branches killed and tree slowly dying as result of blister rust infection.

Figure 7.—White pine blister rust crew eradicating Ribes.